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AUTHOR Gardner, Jo Ann
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ABSTRACT

A study examined the effectiveness of teaching students the vocabulary of mathematics. Subjects in the experimental group, 14 students in a remedial math section of a secondary school basic skills program, were taught the vocabulary and definitions of 50 mathematical terms as identified on the New Jersey High School Proficiency Test, Mathematics. Students in the experimental group developed word meanings and gave reports about items found in the newspaper. Subjects in the control group, 7 students in a similar program, were taught in the traditional manner with no particular emphasis directed toward the specific vocabulary and took the same pre- and posttests as subjects in the experimental group. Results indicated that a significant improvement in test scores occurred when the experimental group was taught certain definitions. (Two tables of data are included; 17 references, the New Jersey High School Proficiency Test (Mathematics), and the vocabulary list are attached.) (RS)

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TEACHING VOCABULARY TO IMPROVE MATHEMATICAL COMPREHENSION AND COMMUNICATION

by

Jo Ann Gardner

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ABSTRACT

The purpose of this study was to test the assumption that there would be no significant difference in test scores between students who were taught the vocabulary of mathematics and those who were taught without that emphasis.

The sample tested two groups of heterogeneously grouped basic skills students in grades nine to twelve.

A comparison of the test scores indicated that a significant change occurred with the experimental group when they were taught the specific vocabulary. The hypothesis that there would be no difference between the means of the two samples was rejected.

The study showed that the teaching of mathematical definitions and vocabulary to at-risk secondary basic skills students helped the experimental group achieve better scores through improved comprehension and understanding of abstract mathematical concepts.

ACKNOWLEDGEMENTS

This project is dedicated to my mother, Ann McClay, whose love of reading and learning were passed on to me; gifts that have never worn out from use. My mother did not live to see me complete this endeavor but her happy spirit has been, and will always be, my inspiration.

Thanks to my husband, Dave, who is always there to encourage me when the going gets rough. His love and support make all things possible for me.

Special thanks must also be given to the students who cooperated and assisted me in the completion of this paper.

My deep appreciation and gratitude go to Dr. Albert J. Mazurkiewicz for his patience and expertise throughout this project.

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Introduction

Statement of the Problem

Many students today are quick to tell you that they hate mathematics. They do not understand the language of mathematics. Business and higher education are complaining that students are not prepared for problem solving. Recognizing this, both the National Council of Teachers of Mathematics and the New Jersey State Department of Education have taken steps to identify areas that must be improved. The great emphasis will be on mathematics as problem solving, communication and comprehension. Students need to know the language of mathematics. An article in Arithmetic Teacher (September, 1990) says, "By discussing and sharing ideas, students develop the need for a common language, appreciate the role of definitions, and eventually grasp the significance of discussing and clarifying assumptions."

Research has shown that having formal instruction in vocabulary is much more effective than simply relying on informal unplanned acquisition of words. The technical vocabulary of mathematic seems to have been left to chance. Students are puzzled when asked to find the "quotient". Teachers seem to fail to use the proper terminology in the false hope that this simplification will make the course easier to learn.

Mathematics learning suffers from the lack of learning in the area of vocabulary. Students can not even ask for help because they are at a loss for terminology to describe the problems they are having.

It's not enough that students must acquire new understanding and insights in

mathematics but they must be able to remember and apply that which is learned. Our job is to teach the new terminology of mathematics in a way that helps students grasp the meaning.

> "We can not remember what we do not understand. Long term memory of technical terminology is semantically encoded; we are not likely to forget what is meaningful. Knowing the meaning plus frequent review or usage is crucial for rapid retrieval of informational terminology stored in the brain. Assimilating the specialized vocabulary is basic to accumulating fundamental knowledge in any field." (Miller, 1991)

Secondary students in the Basic Skills mathematics program have not been successful even after repeated remedial efforts, so the question has to be, what is the missing element? Teachers believe that it is the very obvious idea that there is a major correlation between vocabulary acquisition and comprehension. They are certainly aware of vocabulary and comprehension in the area of reading and great efforts are made to use effective strategies to get students to understand and learn vocabulary.

Perhaps research in the area of teacher training is needed to see if a deficiency occurs in that population. Undergraduate mathematics courses may not make enough of an issue regarding the importance of mathematical vocabulary.

The big question is why students arrive in high school with serious deficiencies and deflated self-esteem in regard to mathematics.

Basic Skills students are already at-risk because of the gaps in their education. If we are going to remediate these secondary students and help them learn the mathematical concepts and procedures needed to solve problems, then we must teach

them the language of mathematics. Our technical world will require that they be trained in the language of computers. This will be impossible if they don't even know the language of mathematics. Our society has only room for those who can work with their brains. Brawn will not serve us as well in the Information Age as it did in the Industrial Age. Factories are run by computers. Computers are run by well trained technicians.

Questions are being raised as to whether students will be overwhelmed with the new task of mathematical comprehension and communication even after having been taught the mathematical vocabulary and definitions. In other nations where more is expected, more mathematics is learned. If our country is to compete, especially here where many foreign born immigrants seem more determined to learn, then it seems desirable to forget the old dualistic mission, pointed out in Everybody Counts (1989) of "minimal mathematics for the majority and advanced mathematics for a few"; and we need to push for a singular focus on a common core of mathematics for all students. We appear to be too easy on our students.

Based on the foregoing, a study to determine what improvement will be gained by secondary students in a Basic Skills mathematics program by teaching mathematical definitions and vocabulary becomes of paramount interest.

Hypothesis

It was hypothesized that no significant difference in mathematics understanding would exist between two samples after one had been taught mathematical definitions.

Assumptions and Limitations

The assumptions in this study revolve around the students who will participate. The students in the study are not classified as special education students but many have learning disabilities. However minimal, many seem to have reading problems, memory problems, or even some behavioral problems; such as, attention deficit disorder. It is assumed that they have normal intelligence and will not be under unusual emotional stress.

The study will take place during a designated amount of time and it is assumed that the students' attendance will be regular so that learning and assessment can take place.

Working in groups, having discussions, writing and making presentations are assumed to be the methods by which language can be best acquired.

The limitations to the study involve the small enrollment of students to be studied. Class sizes range from three to eight so this limits the participation. Students receive remediation for reading and writing, as well as, mathematics.

The age and grade levels are diverse and represent grades nine to twelve. Ability levels range from the fifth to the twelfth. Students who come from many parts of the world are a part of the group. Limitations of English as a second language will be a challenge that will require special consideration.

Definitions

Mathematics: This subject is more than a process of making calculations, it

is understanding concepts well enough to apply them to related problems.

Problem solving: The problems may be single or multi-step word problems or real world applications.

Students at-risk: These students are not doing well in school and are in danger of dropping out of high school.

Vocabulary: The specific definitions used in mathematics.

English as a Second Language (ESL) Students: Students who have come to America from many countries around the world who are learning English as their second language.

Procedures

Two intact samples of students were used to test the hypothesis. The experimental group students were taught the vocabulary and definitions, as identified on the 86-87 HSPT 9 (New Jersey High School Proficiency Test), Mathematics - Part 3. The control group students were taught in the traditional manner with no particular emphasis directed toward the specific vocabulary.

Pretests were given to the experimental and the control groups to establish equivalency of the samples at the outset of the study. Post tests showed growth over the period of instruction. "t" tests were used to test for significance as a result of instructional differences.

Fifty words were selected from the thirty-six item HSPT test to focus on for the vocabulary study. Some words were familiar but some needed their meanings defined. Students used discussion and a mathematics glossary to assign appropriate

meanings to the words. Students had to then develop ideas and concepts represented by the words.

Fourteen students were used as the experimental group. They were a part of the remedial math section of the secondary basic skills program. Six ninth graders, six tenth graders and two eleventh graders took part in the study. Two of the students were ESL students from South America.

The control group started with thirteen students but only seven completed both pre and post tests. Three ninth graders, two tenth graders, one eleventh grader and one twelfth grader completed the study. Two of the students were ESL students from South America and Mexico.

The study was conducted over a three week period. Each class period lasted forty-two minutes. Word meanings were developed by using definitions and examining context clues, as well as examining prefixes, suffixes and root words. Students studied the meanings they wrote in their notebooks.

The experimental group used the words to give reports about items found in the newspaper. Real world mathematics were emphasized so that the words became familiar and were not just mathematics class words.

Results

As can be seen in Table I, at the outset of the study the experimental and control groups showed a minimal difference in the mean. The 4.7 difference shown was not considered significant.

Table I

PRE-TEST SCORES OF THE EXPERIMENTAL AND CONTROL GROUPS

Variable	Mean	STD Deviation	N	t	Significance
experimental	53.79	16.23	14	.61	n.s
control	49.14	17.24	7		

Table II shows that significant progress was made by the experiemental group on the posttest after having received a period of careful mathematical vocabulary instruction. Therefore, a rejection of the negative hypothesis seems valid because of the significant statistical difference.

Table II

POSTTEST SCORES OF THE EXPERIMENTAL AND CONTROL GROUPS

Variable	Mean	STD Deviation	N	t	Significance
experimental	69.43	8.22	14	3.8	.01
control	49.29	16.22	7		

Conclusions & Implications

An analysis of the results of this study indicated that a significant improvement in test scores occurred when the experimental group was taught certain definitions. The fifty words that were selected were taken from Part 3 of the 86-87 New Jersey High School Proficiency Test (HSPT). Even though research says that having formal instruction in vocabulary is much more effective that simply relying on the informal

acquisition of words, not much emphasis is placed on vocabulary in most mathematics classes.

Students seemed to be able to retain the meanings longer when they helped create the appropriate definitions through use of the mathematics glossary. The students' notes and the discussions using the appropriate vocabulary seemed to help them make the words a part of their own language.

Students learned to use the vocabulary as they created problems. Thinking about how to communicate mathematical relationships verbally was a challenge but it seemed to shed light on some of the concepts that had previously been little more than rote recitations with little conceptual value.

Teaching the vocabulary of these mathematical problems required more than a simple definition since many of the words required content knowledge that should have been learned previously by the student. Just as prior knowledge is used to get students ready to read-so must we have students search for prior mathematics knowledge so that errors in their thinking can be corrected and gaps filled in where necessary.

In discussion with the participants about this method of learning, many students were happy and surprised to suddenly find that a simple understanding of what a word like, "probability" meant made the solution of the problem so much easier. Where they would have guessed or skipped over the problem in the past, they now felt a new satisfaction in being able to work out the solution.

Colleagues with whom the results were shared said that this method would take

too much time. This attitude raised the question as to what it is teachers are supposed to be doing; are they supposed to be finishing the book or are they supposed to be teaching the students? It would appear that a lesser amount of content that is well taught would probably help students learn more in the long run.

Teachers will have to accept a lot of new ideas with the implementation of the National Council of Teachers of Mathematics "Standards". However, they will probably do more by improving the methods utilized in math instruction than by throwing out the methods and starting over again. Teachers need lots of teacher in-service and hands-on teacher training if they are to be really effective teachers of mathematics; especially if they are not mathematics majors. Colleges need to face the fact that elementary teachers need more math courses than the one or two being offered today. Teachers need to be computer experts as well, and that means lots of training.

If the elementary teachers were experts in the teaching of mathematical language as suggested in this study, the results could be a marked reduction in the numbers of students in the secondary schools who are so ill-equipped or who hate math or both.

Industry would be out of business in a month if they were run as haphazardly as our schools are run; it's time we asked the teachers what works and set up skilled business people to run the financial end of it, our product is certainly worth it.

To further investigate the findings from this study, two directions seem to require attention. First, the study should be repeated with a larger sample of one

grade only. It would be interesting to see how ninth graders responded. The second area to be investigated would be reading skills as related to word problems. Are the strategies used for narrative the same as the ones needed for expository?

The findings to these studies might bring forth new ideas and procedures that would be helpful to students who seem to be so overcome by word problems.

Maybe the study should be of the teaching methods teachers use to help students approach mathematical vocabulary. Do they use communication enough in class or is the emphasis on lecture type teaching with little response from the class?

Studies and their results will certainly impact on teacher training, the types of materials and texts, instruction in the classroom and the way evaluation is done. Continued research is certainly warranted and better prepared mathematics students will be the reward for the efforts.

RELATED LITERATURE

It doesn't take long to find a document that says that our mathematics curriculum is obsolete. Our technical world needs people who have developed a broad based mathematical power. The power to understand the language of mathematics and to be ready to be retrained as technology advances. Our future workers will have to be skilled in problem solving and will need to have a firm grasp of all the mathematical concepts that help to explain the complexities of our world. Computers and calculators will be as common as paper and pencils.

Once mathematics is recognized as a process, rather that a set of facts, more students will attain a successful understanding and gain the confidence that is missing today. There will be no cowering from mathematics, our students, all students will step forward boldly and confidently.

One of the goals identified by the National Council of Teachers of Mathematics (NCTM) is the idea that we must devise methods that provide "... opportunity for all". (NCTM, 1989) In the Basic Skills Improvement classes teachers deal with lower level mathematics students who often don't have the same opportunities that middle or upper level students have. They require more time than the regular classroom teacher can give. Their need for extra explanation and various modes of presentation can not be addressed in large group instruction. In trying to reach all students we find that the "disadvantaged" can not be easily defined since it may be in the physical, emotional, cultural or social realm or it may be a complicated combination. This variety also creates a challenge when addressing these issues. We want all students to learn mathematics but our methods will have to be adjusted.

Francis Fennell in his article, "Reaching by Teaching" in Arithmetic Teacher (February, 1991) declares that we must teach all children. He says, "The homework-chalk talk-try these-seatword-and-more-homework model must be changed. We must focus on concepts, good questions, interaction, involvement, and a variety of ways to assess our students." This supports the idea of this paper that the proper and precise vocabulary must be taught. Interaction and meaningful dialogue help students understand the concepts.

Fennell says further, "Keep them guessing, challenge them, make each day a new and different experience."

We've come through a series of descriptive terms used to identify our lower level mathematics learners: Title I, Chapter I, Compensatory Education, educationally disadvantaged, slow learners, learning disabled, under-represented and the most current-"at risk". What we haven't done is clearly describe means and methods by which these students can be taught. I suggest that vocabulary be a starting point. Without language, communication is impossible and so is learning.

Researchers want to know the relationship between mathematical language facility, procedural knowledge and mathematics achievement (Bradley, 1988).

We need to understand that the ability to use the precise vocabulary of mathematics with fluency and ease tends to help students gain a complete understanding of mathematical concepts.

Do some students learn this language as they are taught the established sequence of steps used to solve mathematical problems? Carol A. Bradley, in her

research, suggests that the procedural knowledge goes with the language facility, it is the combination that promotes conceptual understanding.

In the case of lower level, ESL, or other disadvantaged mathematics student we need to involve language development along with procedural knowledge and skill. It appears that too little time is spent on "giving reports, having group discussions, writing, and talking about their ideas, holding conversations on important concepts or illustrating their understandings of concepts in varied ways." (Bradley, 1988)

It looks like changes are due in teacher training,materials and texts, classroom instruction and testing and evaluation if the importance of mathematical language facility is proven.

> "Students may lack appropriate vocabulary and syntax to express themselves mathematically but still be able to learn and demonstrate sophisticated knowledge of mathematics. In some circumstances students' understanding of the language used to communicate mathematics may be incomplete or incorrect; these misunderstandings can create subtle barriers to success in the mathematics classroom. Teachers' knowledge of their students cultural backgrounds and the implications of this knowledge for their teaching is crucial in recognizing the impact of language on learning." (NCTM Standards, 1991)

Writing has proven to be an effective and practical tool for teaching mathematical problem solving (Bell and Bell, 1985). If writing becomes a part of the routine we use in our mathematics class, it seems, according to research, that this method will reinforce the concepts and skills being taught. It also seems that the students will be able to take what has been learned and rewrite it in their own language. Once this translation is made and the thoughts are on paper, then the teacher can see if the conceptualization is accurate.

"We do not think and then write, at least not without putting an unnecessary handicap on ourselves. We find out what we think when we write, and in the process put thinking to work - and increase it possibilities." (Smith, 1982)

We still have some questions about which students would profit from writing. It seems that most students might use this alternative instructional method at least some of the time. Surely, the carefully planned learning strategy of using writing with lower level students would enhance their understanding.

English speaking students have plenty of problems with the use of mathematical language so we have to wonder how the ESL students survive. We are given some practical techniques of teaching the terminology of mathematical concepts to non-English speaking students (Kimball, 1990). Cultural orientation plays a role as the teacher uses pictures and role playing. Setting up a play store and naming the real products; cereal, soup, etc., as well as , the prices provide a practical way of teaching. The newspaper provides a plethora of mathematical and cultural concepts.

There is something mysterious in the language of mathematics that causes a block for many people, especially women, Sheila Tobias writes in Overcoming Math Anxiety. She goes on to say that people who can "understand the subtlest emotional nuances in conversation, the most convoluted plots in literature, and the most intricate aspects of a legal case can't seem to grasp the most basic elements of a mathematical demonstration."

What an inheritance of fear students have gotten from parents and teachers

who may have suffered from the same math anxiety. Teachers can get by with the manuals but students have no point of reference and just think that they are dumb and really don't want to risk the pain of failure. Most just give up trying.

In his book Innumeracy, John Allen Paulos believes that just as people learn to read by reading and to write by writing; this can be expanded to solving mathematical problems by doing many problems. Careful explanation of vocabulary and procedures paves the way to understanding and confidence.

The Report of the Eleventh Grade High School Proficiency Test Mathematics Skills Development Committee 1989 stresses Communication and Reasoning and wants students to be able to:

- "Express mathematical ideas in writing or by depicting visually.
- Understand, interpret, and evaluate mathematical ideas that are presented in written or visual form.
- Understand and use mathematical language, notation and structure to:
  - represent ideas,
  - describe relationships,
  - model situations.
- Use reasoning to develop convincing arguments for mathematical statements.
- Use reasoning to verify conclusions and judge the validity of arguments."

We can see clearly that language exerts a strong influence on cognition, expression and communication.

National Goals for American Education states "Goal 4. By the year 2000 U.S. students will be first in the world in mathematics and science achievement."

> "Mathematics deepens and develops through communication. Mathematical ideas become tangible when people find words and symbols to express them. The only way that mathematical culture can be passed on the new generations is through the medium of ordinary language, along with some special symbols. The interpretation of that language and those symbols requires learners to see them in much the same sense that teachers do. That demands sharing on the part of the teacher and the learner - a mutual construction of meaning.
>
> Finally, by learning to express their ideas to one another, students can begin to appreciate the nuances of meaning that natural language often masks, but that the precise language of mathematical exposition attempts to distinguish." (Silver, Kilpatrick, Schlesinger, 1990)

"To understand what they learn, students must enact for themselves verbs that permeate the mathematics curriculum: "examine", "represent", "transform", "solve", "apply", "prove" and "communicate". This happens most readily when student work in groups, engage in discussion, make presentations, and in other ways take charge of their own learning." (Mathematical Science Education Board, 1989)

The value of note taking in mathematics class becomes apparent when students attempt to do their homework. What seems so clear to them in class now has no meaning. This is the time to refer to their notes. This is when the instruction and practice of the proper use of the language of mathematics helps the student communicate the ideas learned earlier. Students need to be taught how to take notes. The teacher must model.

"Examples of specific writing tasks include three ideas described by Evans and they are: "how to", "definitions", and "troubleshooting". "How to's" require verbal

explanation about how to do something - simplify an algebraic fraction, bisect an angle, solve a time problem and so on."

"Definitions" require students to write their own definitions or explanations of terms being learned in mathematics. Having students copy the definition from the textbook is only practice in copying - not writing, and not learning." (Mc Intosh, 1991)

Logs, journals, expository writing, and creative writing have been found appropriate for mathematics classes. Researchers suggest forms and prompts to get mathematics students motivated. The teacher can examine the thought process and suggest vocabulary needed to clarify a concept. Writers of mathematics books would be good resource people to come to class.

Everybody Counts (1989) a Report to the Nation on the Future of Mathematics is a National Research Council report that emphasizes how crucial for all aspects of our nation that all students receive high quality education in mathematics.

"Students construct meaning as they learn mathematics. They use what they are taught to modify their prior beliefs and behavior not simply to record and store what they are told. It is students' acts of construction that build their mathematical power and enable them to solve problems they have never seen before." (Everybody Counts, 1989)

The NCTM Standards (1991) wants to make major shifts that will empower the students to take charge of their mathematical education. They want every child

to learn; minorities, females, and even the so called, "at-risk".

Mathematical communications can take place in cooperative groups. A teacher should monitor students use of mathematical language to help develop their ability to communicate mathematics.

"Research indicates that mathematical material is the most difficult content area material to read with more concepts per word, per sentence and per paragraph than any other area." (Schell, 1981) It appears that not enough attention has been given to the relation between reading and writing mathematics. Using some of the same comprehension skill building strategies would probably be very helpful when used with the mathematics textbook.

We know that many differences exist between the language of mathematics and English prose. When students do not learn the precise nature of the mathematical language they become frustrated and often feel defeated. Comprehension is impossible. Mathematics teachers feel that it's not their job to teach reading but it is apparent that some of the skills used in learning reading comprehension would be applicable.

The use of concrete objects can help students understand the more abstract ideas. Many manipulatives have been found to help students learn what words alone can not make clear and at the same time the concrete objects force the students to find the language to describe what they are discovering. As skills are taught the students begin to relax and find mathematics less threatening.

Some researchers say that a lack of arithmetic understanding gets in the way

of students' ability to solve word problems. They read the words but get no understanding until some of the words are defined and concepts clarified (Noyce and Christie, 1989)

> "Noticing that her students seem to have difficulty understanding or even memorizing the precise definitions of mathematical concepts in the textbooks, Evans decided to have them describe the concepts in their own language by writing definitions. The greatest benefit she reported as a result of definition writing activities was the opportunity for her to see immediately which of her students understood the concepts she was teaching and which did not. She also noted that her students discovered that their own definitions were easier to remember than the textbook definitions." (Noyce and Christie, 1989)

It is true that we understand language better when we put it into our own language. It belongs to us only when we have made that translation.

"Reshaping School Mathematics" advocates reform of mathematics education to suit the new technological demands. Heightened expectation will surely lead to better performance. High School general math is a waste of time and needs to be put in touch with the real world of computers and calculators. Students are not helped by the endless and meaningless repetition of drills of mathematics facts in isolation.

> "By stressing mathematics as a language in which students express ideas, we enable students to develop a framework that can be drawn upon in the future, when rules may have been forgotten but the structure of mathematical language remains embedded in memory as a foundation for reconstruction. Learning the language of mathematics requires immersion in situations that are sufficiently complex to offer diversity; individual, small group, or large group instruction; a variety of mathematical domains; and open and flexible methods.
>
> By affirming the importance of mathematics as a language and science of patterns we reset the gyroscopes that guide school mathematics. Instead of being viewed as an immutable collection of

> absolute truths, mathematics will be seen as it is - as an evolving, pragmatic discipline that seeks to understand the behavior of patterns in science, in society and in everyday life." (Mathematical Science Education Board-National Research Council, 1990)

Mathematics deepens and develops through communication. Mathematical ideas become tangible when people find words and symbols to describe them. The acquisition of language is a very complicated process and perhaps a future study might help us find what makes it easier for some people and a puzzle for others.

Purpose

The purpose of this study is to determine whether the teaching of mathematical definitions and vocabulary will enable "at-risk" students to better understand and communicate mathematical concepts. Another purpose is to see if this new understanding will improve their confidence and cause them to approach more advanced forms of mathematics. We want students to explore and to be able to verbalize their mathematical ideas. We need to show that mathematics is exciting and alive. Survival in this highly technical world demands careful reasoning and disciplined understanding along with a cooperative effort toward problem solving. Dr. Lola J. May in her resource book, Strengthening Your Math Program, (used with teachers at her seminars) says, "Change is here. Change is now. This change in mathematics is not an educational fad. This change is because our society has changed how they use mathematics with the development for new technology."

I propose to start with language. In the 1989 edition of the book, Everybody Counts (1989) the authors state:

> "Education research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding. To understand what they learn, they must enact for themselves verbs that permeate the mathematics curriculum: 'examine', 'represent', 'transform', 'solve', apply', 'prove', communicate'. This happens most readily when students work in groups, engage in discussion, make presentations, and in other ways take charge of their own learning."

The work of the teacher is to make this type of learning a reality by use of manipulatives and real life situations.

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APPENDICES

APPENDIX A

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MATHEMATICS—PART 3

Directions:
Work each problem. Mark the letter for your answer on your answer folder. UNLESS THE PROBLEM STATES OTHERWISE, DO NOT FIGURE SALES TAX IN YOUR ANSWERS TO PROBLEMS INVOLVING PURCHASES.

165. The Nuñez family is buying a new car priced at $9,750.00. If the sales tax is 6%, how much will the sales tax be?

A. $600.00
B. $585.00
C. $60.00
D. $58.50

168. At the student-faculty basketball game, Mr. Shores scored 16 of the 40 points his team scored. What percent of the faculty's total points were scored by Mr. Shores?

A. 24%
B. 40%
C. 60%
D. 64%

sales tax/selling price

percent

166. A skateboard costs $75.00. After a discount of 15% to students, what is the cost to students?

A. $60.00
B. $63.75
C. $70.00
D. $71.25

169. Laura bought a softball glove at 40% off the original price. This discount saved her $14.40. What was the original price of the glove?

A. $ 5.76
B. $20.16
C. $36.00
D. $50.40

discount/percent

discount/original price

167. A tire at the catalog store is 10% off the regular price of $48.00. The gas station is selling the same tire at $\frac{1}{3}$ off its regular price of $60.00. What is the lower price per tire?

A. $36.00
B. $38.00
C. $40.00
D. $43.20

170. There are 3 orange, 8 red, 3 green and 6 yellow gumdrops in a bag. If you were to pick one gumdrop from the bag without looking, what is the probability that it will be green?

A. $\frac{3}{20}$
B. $\frac{3}{17}$
C. $\frac{1}{4}$
D. $\frac{17}{20}$

GO ON TO THE NEXT PAGE.

equivalent fraction/decimal/percent

probability

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171. The car dealership sold 43 cars in January, 156 cars in February, 100 cars in March, and 201 cars in April. What was the average number of cars sold each month from January through April?

A. 125 cars
B. 100 cars
C. 86 cars
D. 75 cars

average

172. If Tony can deliver 24 newspapers in half an hour, how many newspapers could he deliver in 2 hours, working at the same rate?

A. 12 newspapers
B. 48 newspapers
C. 72 newspapers
D. 96 newspapers

proportion

173. To redecorate her room, Sharon bought 1 gallon of paint for $14.50, 4 rolls of wallpaper at $12.00 per roll, and 2 sheets of paneling at 2 sheets for $18.00. What was the total cost of these materials?

A. $42.50
B. $67.50
C. $78.50
D. $94.50

total cost

174. The high temperature for Sunday was 8° C. A year ago, the high temperature for the day was −4° C. What is the difference between these two temperatures?

A. 32° C
B. 12° C
C. 4° C
D. 2° C

temperature/degrees

For questions 175-179, all answers should be reduced to lowest terms.

175. $\frac{1}{3}$

$\frac{1}{12}$

$+\ \frac{2}{9}$

A. $\frac{23}{36}$
B. $\frac{19}{36}$
C. $\frac{1}{6}$
D. $\frac{1}{9}$

sum/ common denominator

176. $\frac{4}{5} - \frac{1}{6} = __$

A. $\frac{29}{30}$
B. $\frac{19}{30}$
C. $\frac{1}{10}$
D. $\frac{1}{30}$

difference/common denominator

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177. $\frac{4}{5} + \frac{2}{3} - \frac{1}{15} = —$

A. $1\frac{8}{15}$

B. $1\frac{2}{5}$

C. $\frac{7}{15}$

D. $\frac{1}{3}$

common denominator

178. $3\frac{3}{10} \times \frac{5}{9} = —$

A. $1\frac{2}{3}$

B. $1\frac{5}{6}$

C. $3\frac{1}{6}$

D. $3\frac{15}{19}$

numerator/denominator

improper fraction/

179. $24 - \frac{4}{3} = —$

A. 32

B. $25\frac{1}{3}$

C. 18

D. 2

reciprocal

180. What is 120% of 90?

A. 135

B. 108

C. 75

D. 18

percent

181. $12.4 \times 0.08 = —$

A. 0.992

B. 9.632

C. 12.032

D. 96.032

decimal

182. $2.3\overline{)13.823}$

A. 0.601

B. 6.01

C. 6.1

D. 60.1

divisor/dividend/quotient

183. What percent of 25 is 20?

A. 125%

B. 90%

C. 80%

D. 12.5%

percent

184. $17 - 6.03 = —$

A. 10.97

B. 11.03

C. 11.07

D. 11.97

whole number/decimal

185. Let $p = 6$ and $r = 2$. Evaluate

$23 + 2p - 10r - 15$

A. 12

B. 10

C. 0

D. −48

like terms/solution set

58

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186. Simplify $15 + 3s + 4(2s - 3)$

A. $5s + 12$
B. $5s + 16$
C. $8s + 3$
D. $11s + 3$

order of operations

187. Solve for r:

$13 - 6r = 5$

A. -3
B. -2
C. $-\frac{5}{78}$
D. $\frac{4}{3}$

number sentence/ variables/equation

188. Simplify $(7)(-2) + 3 - 5$

A. 12
B. −6
C. −16
D. −47

simplify/parentheses

189. Find the value of X to make the following ratios equal:

$\frac{3}{12}\ \frac{12}{48}\ \frac{X}{56}$

A. 48
B. 28
C. 21
D. 14

ratio/proportion

190. Lines in the same plane that have no points in common are

A. imaginary lines.
B. perpendicular lines.
C. intersecting lines.
D. parallel lines.

intersecting
imaginary lines
parallel/ perpendicular

191. Convert 0.60 to a fraction.

A. $\frac{3}{50}$
B. $\frac{4}{15}$
C. $\frac{3}{5}$
D. $\frac{2}{3}$

decimal/fraction

192. Express $\frac{9}{50}$ as a percent.

A. 9%
B. 18%
C. 45%
D. 55.5%

fraction/percent

193. For a science project, the class collected exactly 1 liter of pond water. If each of the 10 students took 25 ml of water to examine, how many milliliters (ml) of water remained from the original sample?

A. 240 ml
B. 750 ml
C. 975 ml
D. 9750 ml

liter/ milliliter

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Use this figure to answer question 194.

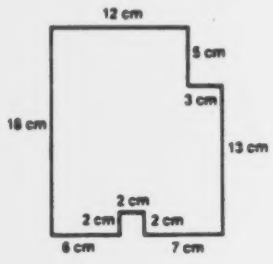
$\overline{CD}$ is a straight line.

194. If ∠CGE measures 30°, what is the measure of ∠EGD?

A. 30°
B. 50°
C. 90°
D. 150°

complementary

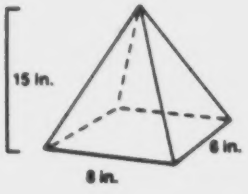
196. What is the perimeter of this figure?



A. 66 cm
B. 70 cm
C. 72 cm
D. 76 cm

perimeter

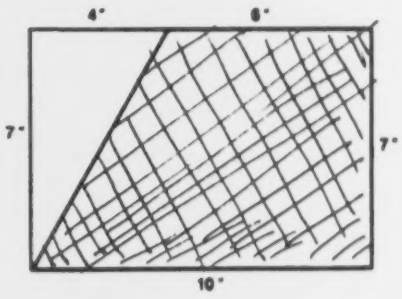
195. The base of the pyramid below is a rectangle. Find the volume of the pyramid using the formula $V = \frac{1}{3}Bh$. (B = area of the base and h = height.)



A. 720 cubic inches
B. 240 cubic inches
C. 30 cubic inches
D. 16 cubic inches

pyramid/rectangle/ area/formula

197. What is the area of the shaded portion of this rectangle?



A. 70 square inches
B. 56 square inches
C. 42 square inches
D. 14 square inches

shaded/portion rectangle

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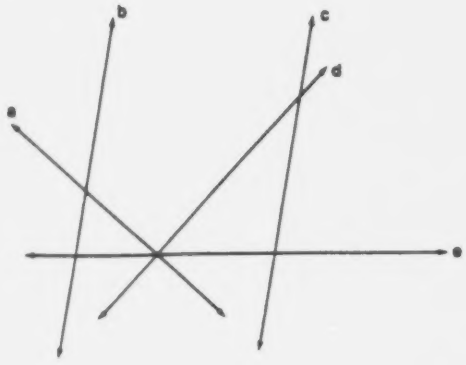
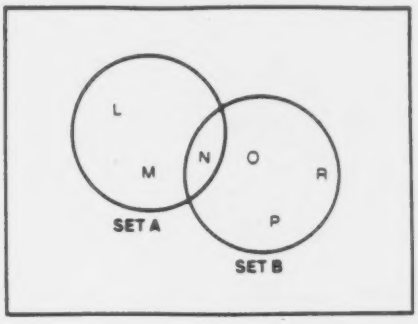
198. Which two lines below appear to be perpendicular?



A. a and d
B. a and e
C. b and c
D. d and e

perpendicula

Use this diagram to answer question 199.



199. Which of the following sets is a subset of Set B?

A. {L, M, N, O, P, R}
B. {N, P}
C. {M, N}
D. {L, M}

Venn diagram/subset

200. Which set of fractions shows its elements ordered from greatest to least?

A. $\{\frac{1}{2}, \frac{2}{3}, \frac{5}{6}, \frac{7}{9}\}$

B. $\{\frac{7}{9}, \frac{5}{6}, \frac{2}{3}, \frac{1}{2}\}$

C. $\{\frac{5}{6}, \frac{7}{9}, \frac{2}{3}, \frac{1}{2}\}$

D. $\{\frac{1}{2}, \frac{2}{3}, \frac{7}{9}, \frac{5}{6}\}$

least

END OF PART 3
YOU MAY CHECK YOUR WORK ON THIS PART ONLY

STOP

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APPENDIX B

VOCABULARY TEST
WORDS LISTED ACCORDING TO APPEARANCE
IN PART 3 - 86-87 HSPT

sales tax
selling price
discount
percent
equivalent
fraction
decimal
original
probability
average
proportion
total cost
temperature
degrees
sum
common denominator
difference
numerator
denominator
improper fraction
decimal
divisor
dividend
quotient
whole number
like terms
solution set
shaded portion
order of operations
number sentence subset
variables
equation
simplify
parentheses
ratio
parallel
intersecting
imaginary lines
perpendicular
liter
milliliter
complementary
pyramid
rectangle
area
formula
perimeter
Venn diagram
least